ALD Sapphire Coating for Large Area Soft X-ray Mirrors

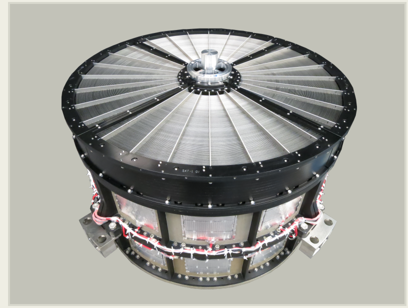
Completed Technology Project (2017 - 2018)

Project Introduction

This proposed work is to demonstrate that the already established ALD coating method can be applied to the X-ray mirror fabrication and is suitable to produce an additional thin layer on X-ray reflectors. All the soft X-ray mirrors previously flown employed a heavy metal coating, such as Ir, Au, and Pt, in order to increase the upper limit of their sensitive energy band beyond 10 keV. However, it is known that such a heavy element is not optimal for the softer X-ray reflection < ~7 keV. The heavy element has a high electron density, which is ideal to reflect X-rays, but also attenuates them during the reflection process. The heavy element also creates absorption edge structures in the mirror effective area energy response, particularly a big sharp drop around the L absorption edge around 2 keV. It has been suggested by many people that a thin light element layer, such as Ni, Cu, C, etc., on top of the heavy element can enhance the effective area as well as eliminate the L-edge structure. Only a very thin layer is required for this enhancement, but a segmented X-ray mirror contains thousands of reflectors inside. An additional complication tends to be avoided for the flight project. On the other hand, the ALD coating method can in principle coat many substrates simultaneously with precise thickness control. This will not take much cost and schedule of the flight project. In this task, we will use Al2O3 which can provide a stable and robust reflecting surface. We intend to demonstrate that the ALD can produce uniform thickness over the large surface area and among multiple reflectors in one coating run.

Anticipated Benefits

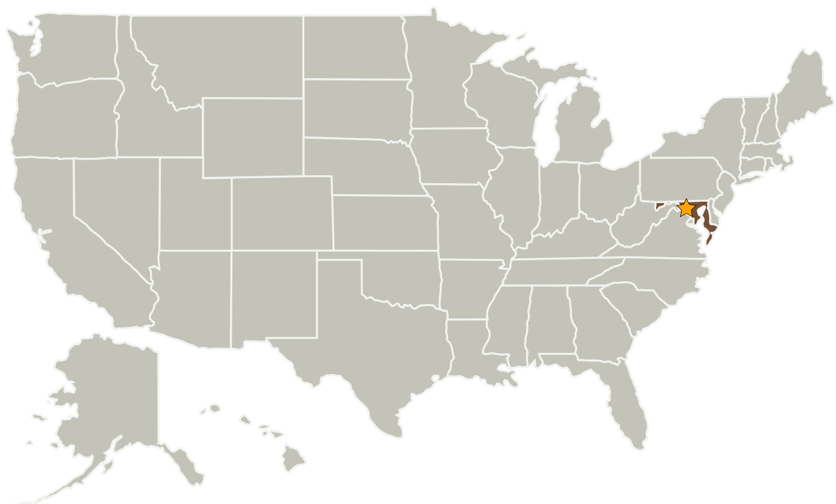
The Al2O3 layer will increase the X-ray mirror effective area by ~30% (depending on the mirror size and its focal length), which will provide future X-ray astronomy missions with 30% more photons to each observation or 30% more observing time, at almost no cost (budget and schedule) to the mission.



Grazing incidence mirror to be ALD coated

Table of Contents

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
Maryland

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Managers:

Megan E Eckart
Timothy D Beach

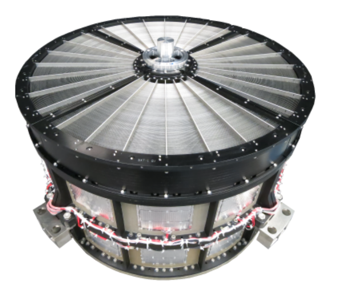
Principal Investigator:

Takashi Okajima

Co-Investigator:

Vivek H Dwivedi

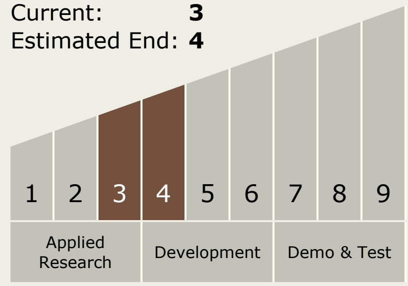
Images



Large Area X-ray Mirrors
Grazing incidence mirror to be ALD coated
(https://techport.nasa.gov/image/28282)

Technology Maturity (TRL)

Start: **3**
Current: **3**
Estimated End: **4**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - └ TX08.2 Observatories
    - └ TX08.2.1 Mirror Systems

Target Destinations

Outside the Solar System, Foundational Knowledge